The death of Dr. R. M. S. Jackson, at Chattanooga, January 18, 1865, aged 51, was announced by the Secretary.

The committee to which was referred the communication by Mr. Lesquereux, for the Transactions, recommended its publication, which was, on motion of Prof. Cresson, so ordered, and the committee discharged.

Mr. Briggs made a communication to the Society on the effects of impure air on human health, and the supposed necessity of aqueous vapor to a perfect system of hot air ventilation.* The subject was afterwards discussed by Prof. Cresson, Dr. Coates, who referred especially to the experiments of Dr. De La Roche with hot saturated air on animals, and Dr. Wilcocks.

Pending nominations, Nos. 524, 525, and 526, were read.

The committee appointed January 6, to report on the Magellanic Premium, reported progress.

And the Society was adjourned.

Stated Meeting, February 17, 1865.

Present, ten members.

Mr. Peale in the Chair.

Letters accepting membership were received from Mr. Bost, dated La Force, January 23, 1865, and Prof. Winchell, dated Ann Arbor, January 30, 1865.

Letters of correspondence were received from the Russian Observatory, the N. H. S. Moscow, the Royal Academies at Stockholm and Leipsig, and the Royal Asiatic Society of Great Britain and Ireland.

Donations for the Library were received from the Russian Observatory, the Societies at Leipsig, Stockholm, and Haarlem, the Asylums at La Force, the Royal Astronomical,

* [See at the end of No. 73.—Sec. A. P. S.]

British Meteorological and Royal Geographical Societies, at London, the Edinburgh Observatory, Royal Irish Academy, and Prof. Houghton, the Boston Library, and Messrs. Blanchard & Lea.

The death of Capt. J. M. Gilliss, Superintendent of the United States Naval Observatory at Washington, February 19, 1865, aged about 55, was announced by Mr. Trego, and on motion of Mr. Fraley, Prof. Henry was appointed to prepare an obituary notice of the deceased.

The Secretary read a communication from Mr. Alexander Trippel, of Bethlehem, with drawings, illustrating Dr. Schinz's gas-generator for puddling and heating furnaces.

REHEATING FURNACE WITH GAS-HEATING FOR ANTHRACITE.

This furnace, which is represented in the accompanying plans, has the form and size of those in use at the Bethlehem Iron-works, with the exception of the fire-box, for which gas-generators are substituted, to convert the fuel into gas, previous to its combustion in the furnace.

The advantages of heating by gaseous fuel are now well known, and the system has been in actual operation ever since 1838, when, in Germany, Mr. Bishoff first used the tunnel-head gases of iron-blast furnaces.* Since then, the principle of converting fuel first into gas, before its application for heating bodies, has been variously extended and applied, especially for metallurgical operations, and here again more than for other purposes, for reheating and puddling furnaces. Nearly all sorts of fuel have been tried: charcoal, kiln-dried wood, peat, bituminous, and anthracite-like coals; and although success was not always fully achieved, enough was proved that the system offers considerable economy in fuel, and cleanliness of operation in the furnace, which, for some reasons, is of exceedingly great value. The want of success is, however, not due to the sys-

[* The invention of the use of the tunnel-head gases was decided in the celebrated lawsuit of the agent of Favre du Four v. the American Iron-masters, to belong to one of the Iron-masters of Pennsylvania, Mr. Bell, of Huntingdon County. See Iron Manufacturer's Guide, New York, 1858. Sec. A. P. S.]

tem; but in all cases of unsuccessfulness it could easily be proved, that the construction of the furnace had not been in accordance with facts, well and conclusively established by science, as well as practical experience, and was principally caused by a want of knowledge of the nature of fuel, and its chemical composition, the action of its component parts, when mixed with the oxygen contained in the atmospheric air, and the requisite conditions for a perfect combustion. From my own observation I can say, that the so called gas-furnaces have been constructed in such an irrational way, that success would have been either accidental or a miracle. Still, the possibility, or rather certainty, of making a much better use of, and obtaining a considerable higher useful effect from, fuel of all kinds, when first converted into gas, has occupied the minds of some of the most prominent men, and naturally more so in countries where the consumption of fuel is in excess of its production; and while some of the greatest savants have now proved conclusively that heat is equivalent to power, others have, in a more practical direction, tried to find the conditions necessary to obtain all the useful effect a fuel can furnish according to theory.

Foremost in these efforts has been Prof. Charles Shinz, editor of a large work on "The Application of Heat," and several other works treating similar subjects. Mr. Schinz, an eminent scholar in physics and chemistry, and gifted with an uncommon experience in many technical branches of industry, has shown that the most important conditions for a perfect combustion have mostly been overlooked; and, in comparing the effect of the hitherto best methods of heating with that which fuel ought and can give, he finds the following results:

Caloric Equivalent.

Fuel.	*Usual Method.*	*Gas-heating.*
Kiln-dried wood, . . .	2498 calorics.	3891 calorics.
Same, with 20 per cent. moisture,	1890 "	3006 "
Kiln-dried peat, . . .	3030 "	4574 "
Lignite (brown coal), . .	3651 "	5419 "
Bituminous coal, . . .	5228 "	7580 "
Anthracite, ...	5423 "	8034 "

It will be seen that the proportion of effect gives to the gas-heating method in all cases over 30 per cent., while comparisons with some old practised furnaces will show as much as 52 per cent. saving in fuel.

The most essential desiderata for a perfect combustion and the highest possible useful effect are, according to Mr. Schinz,

First. Stochiometric proportioning of air and gases.

Second. Sufficient contact surface between air and gas, and different velocities for each of them.

Third. Compression of the mixed gases and air at the moment of combustion.

Fourth. Some criterion, whereby to determine whether or not a perfect combustion takes place.

It is hardly necessary to mention that, in order to make these points, the chemical composition of the fuel must be well known; and that exact calculations have to be made with regard to all dimensions of the furnace. The rules and regulations by which to gain these results, and the peculiar construction of the furnace, form the chief points which distinguishes Mr. Schinz's system from others. His furnaces were rewarded with the prize medal in the late London Exhibition, and have since been patented in Europe and the United States. Wherever they have been in use, they have given satisfaction in every respect.

As already observed, the present descriptions and drawings represent a reheating furnace, of the form and size of those built and used at the Bethlehem Iron-works, by John Fritz, Esq., superintendent of the establishment. They have the advantage of combining the most approved form with carefully designed gas-generators for anthracite coal.

Compared with the present consumption of coals in well-constructed furnaces, the gas-heating system would save about 26 per cent. on fuel, and allow the use of small coal, such as chestnut in the place of lump, or lump and pea coal in equal parts. Another very considerable advantage is the absence of ashes in the hearth, which often prevents a perfect welding, and produces an inferior quality of iron. This circumstance alone is doubtless, a sufficient inducement for the introduction of the gas-heating form of furnace, as the evil influence of cinders is especially felt when fan-blowers are employed, and when large plates of a faultless quality have to be produced. It is further evident, that the gas furnaces will diminish the loss of metal by preventing its oxidation or burning; while the system admits equally, when so desired, an excess of air, and thereby a powerful oxidation, which, especially during a certain period in the puddling furnace, will assist in expelling silicium, phosphorus, and sulphur.

In presenting the great advantages of converting fuel into gas before its practical application, I wish to state that, although this invention is not new, and has been in actual use for twenty-five years, it is now for the first time brought into a systematical form, based upon scientific principles and facts shown by experience; and Mr. Schinz has certainly the incontestable merit of being the author of this system.

A question of the greatest importance for industry,—the rational use of fuel,—discussed in so many ways in a scientific and practical view, to which a great number of improvements and inventions are attached, has, nevertheless, been solved so far in a very imperfect and irrational way; and good results were more accidental than based upon sound calculations, as already said.

I will not pretend that Mr. Schinz's system is at present of equal advantage for all applications, although it is equally well founded on true principles; but for purposes where intense heat is required, it is certainly the most rational and advantageous of all known. With regard to the presented furnace, I will mention that its first cost is considerable higher than that of ordinary furnaces, but this difference is made up by the saving in fuel within four to six months. It is not to be denied that a close attention and moderate skill is required for its construction, management, and repair; but there is no doubt that, with a strict adherence to the rules laid down, an intelligent manager will find no difficulties, when aided by the good-will of the workmen, to obtain all the desired results.

In the plates *I* to *IV*, we have the different sections of the furnace represented. The six gas-generators are marked *A* 1 to *A* 6; the main canal for the fan-blast with *B*, and the gas-flues, which conduct the gas from the generators into the furnace, with *C* 1 to *C* 6. In plan *IV*, we have in *D* the pipes which lead the cold air from *B*, under the boiler into the hot air pipes *F*, and from there the heated air goes through *H*, into the injector *J*.

In plan *I*, we see in *K* the combustion canal, in which gas and air for combustion are intermingled, from whence they enter with their initial temperature into the furnace, *L*, thence through the flue, *M*, between the boiler and hot-air pipes, to be evacuated in the chimney, *P*.

The *Gas-Generators* are, as will be seen in plate *I* and *III*, 3′ 3″ wide, and in the clear, average 4 feet in height. The doors, *Fig.* 1 *a*, and 1 *b*, plate *V*, close the ash-pits air-tight. In them is a small glass plate, to observe the burning of the coal in the generators.

The step grates are marked in plate *III*, with *A* 1 to *A* 6, and drawn in details in plate *VI*, *Fig.* 4; they have a surface of 11.5 square feet each.

The apparatus to charge the coal in the generators is seen in plate *V*, *Fig.* 2, in detail. On a cast-iron plate, fastened to the wall, plate *VI*, *Fig.* 22, moves another, plate *V*, *Fig.* 2, which is provided with a rack, and receives a fire-proof tile within four flanges, which covers the square openings of the first plate when the generator is closed, and can be opened by means of a section of wheel and lever acting on the rack. There is further a box on the upper plate, which receives the coal when the generator is closed, and from which they drop into the latter when it is opened.

The gas which is produced in the generators, is conducted through the gas flues, *C* 1 to *C* 6, plate *I*, *II*, *III;* they have 46, respectively 58 square inches opening each, and unite in the space, *E*, below the combustion canal, *K*, from whence they pass the front of the hot-air injector, *J*, and are consumed in the canal, *K*.

Blast Canals. A fan, with a capacity of 1700 cubic feet of blast per minute, delivers the same through the main canal, *B*, plate *I*, *III*, *IV*, to the generators to produce the gas, and to the hot-blast injector to consume the same. Two eight-inch pipes, *D*, carry the portion of air for the injector from the main channel in the room below the boilers, where it circulates in a length of about 100 feet, and becomes heated to 612° Fahrenheit in the pipes, *F*, from whence it enters through the pipes, *H*, in the injector, *N*. The latter is represented in plate *VI*, in several sections; has a length of 5′ 9½″ by 1′ 3¾″ height, and 1′ 9¾″, respectively, 6″ width. It is provided with two slide-valves of 50¾″ square opening each, represented in plate *VI*, *Fig.* 12, by means of which the influx of hot air can be regulated.

The blast for the generators is taken from the main channel through branch-pipes of 6″ diameter, then passes through an aperture in the wall under the respective fire grates. The end pieces are provided with circular slide-valves, having an opening of 31 square inches each; they are represented in plan *III*, *section G*, *H*, *Fig.* 3, and plate *VI*, *Fig.* 6. By means of these valves and the corresponding gearing and levers, the influx of cold air under the grates is regulated.

The combustible gas which flows through the flues, *C* 1 to *C* 6, unites in the vertically inclined space, *E*, then passes the injector, provided with 52 holes of 1.19″ diameter, through which the hot air escapes and intermingles in so many cones, as holes, with the gas in the combustion flue, *K*. The latter has a width of 4′ 2″, with a mean height of 1′ 2½″, consequently a cross section of 5.3 square feet, with a length of 4′ 8″. In commencing operations with the furnace, the hot-air valve is closed, the gases pass unburned through the hearth, escaping through all apertures with the blue flame of carbonic oxide gas. Subsequently the air is admitted by degrees, until the flames disappear, and the burnt gases, passing over the hearth, appear clear, bright, and transparent. To avoid oxidation, a little excess of gas is admitted.

The furnace, *L*, has a length of 12′, a width of 5′, and a mean height from hearth to arch of 1′ 11″. The hearth is seen in plate *I*, *Figs.* 1 and 2, and is built in the usual manner, but may be made as judged best by the constructor. The walls and casing are seen in plate *I*, *IV*. The arch has a spring of 4 inches.

The boiler is placed above the furnace, as in most cases, and rests, together with the walls, etc., upon six large iron columns with their frames, and upon two supports in the centre. The products of combustion enter from the flue beneath the boiler, and pass all around the hot-air pipes; the boiler is provided with a flue, and offers a total heating surface of 263 square feet, equivalent to at least 22 horse power.

In the several plans, we see the arrangement to support the boiler wall are rails and cast-iron plates. The clear opening of the flue leading to the chimney is here only one square foot, in order to compress the gases in the combustion canal, *K*, but room is left to increase the same, if found necessary, to two or three square feet.

Calculation for the Furnace. The former consumption of anthracite for the furnace is presumed to have been 10.2 tons for 24 hours, or 952 lbs. per hour.

In admitting the most advantageous mode of heating with fan blast in the usual way, and estimating the temperature in the furnace to 2912° Fahrenheit, as the extreme, we have as useful effect:

4161° initial temp. of anthracite.
Minus 2912° temp. of furnace.

1249° divided by 2912°—0.30 = 30 per cent.

The same fuel gives with gas-heating,

$$\frac{4928^\circ - 2912^\circ}{4928} = 0.409\text{, or 40 per cent.}$$

We can consequently diminish the fuel at the ratio of 40.9:30 = 10.2 tons: χ = 7.4 tons, or 27.4 per cent. saving in fuel.

In consuming 699 lbs. of fuel per hour, we have per second 0.194 lbs., which produces 80 cubic feet of gas, with a temperature of 2480° Fahrenheit, requiring 10.59 cubic feet of air, reduced to 32° F. temperature for its production, being 636 cubic feet per minute.

We need further for the *combustion* of 80 cubic feet of gas, 34.3 cubic feet of air at 572° Fahrenheit.

The products of combustion amount to 300.8 cubic feet per second, at the initial temperature of 4928° Fahrenheit.

The formula for produced volume of combustion:

$V = v\,(1 + at)$.

$V =$ expanded volume (300.8).

$v =$ volume at 0° (27.4 cub. feet).

$a =$ expansive coefficient (0.003665).

$t =$ required temperature (2720° Celsius).

The contact surface between air and gas, which is required for a perfect combustion of the latter, is calculated to 122 square feet. The combustion canal being 3′ 8″ long, its cross section = 5.3 square feet, and the number of tuyers in the injector being 52, we can imagine 52 air cones with 0.098 + 0.328 = 0.213 feet mean diameter, and 3′ 8″ in length. The 52 cones give consequently a surface of 52 (0.213, 3.14, 3.66) = 127.3 square feet, a little more than above calculated.

The cross section of the fifty-two tuyers in the injector is 52 (0.04922.3.14) = 0.39 square feet; the quantity of air at 572° passing through per minute, 60.34.3 = 2058 cubic feet, or reduced to 978 cubic feet, at 32° F. and per minute.

The velocity of the air at the tuyers, $V = \frac{2058}{0.39} = 5277$ feet per minute, or 87 feet per second.

The head corresponding to this velocity = 1.5 inch in a water column, or 115.7 feet in an air column.

The velocity V of the same air, when passing at 32° through two tubes of 8 inches diameter, is $\frac{978}{0.74} = 1321$ feet per minute, or 22 feet per second.

The head just mentioned has, however, to be increased somewhat, for two reasons:

First. For the suction caused in the gas-flues by the streaming air; and,

Second. To cause a certain pressure on the air and gas in contact.

In this case we will be safe to add 10 per cent. of head.

The cross section of the gas combustion canal is 5.3 square feet, less the cross section of the tuyers, 0.395 square feet = 4.905 square feet. The quantity of gas entering this canal is 80 cubic feet per second, or 4800 cubic feet per minute. The velocity will be then at its entrance, $V = \frac{4800}{4.905} = 978$ feet per minute, and 16.3 feet per second.

As the smallest cross section of the gas-flues is = 3.85 square feet, we have the velocity in them, $V = \frac{4800}{3.85} = 1246$ feet per minute, and 20.8 feet per second, with a corresponding head of = 0.087 inches in a water column, or 6.74 feet in an air column. The pressure in the air pipes, branching out from the main canal and leading to the hot air apparatus, being necessarily the same as that of the tuyers in the injector, = 1.5 inches in a water column, we have to regulate the circular valves, so as to admit per second 10.59 cubic feet of air under the same pressure $= \frac{10.59}{87.6} =$ 0.0203 square feet for each generator = 3 square inches.

The amount of consumed coal per hour is 952 lbs. for six generators, and 158 lbs. for one, and per hour.

The open spaces of the coal are estimated to be about 2.14 square feet for each grate, and the velocity of produced gas in the generator $= \frac{80}{2.146} = 6\ 23$ feet per second.

There were 18048 cubic feet products of combustion at a temperature of 4928° Fahrenheit, per minute. As they pass under the boiler with a temperature of 2912° Fahrenheit, their volume is reduced to 7320 cubic feet (27.46. [4.46.60]); and when they leave the boiler with an estimated temperature of 1301° Fahrenheit, it is further reduced to 5832 cubic feet (27.46. [3.54.60]), by the diminished expansion.

We would have then a velocity of $\frac{5832}{60} = 97$ feet per second.

The cross section of the entrance of the gas in the chimney is 1 square foot, and the corresponding head = 1.86 inches in a water column, or 144 feet in an air column.

Comparing this head with that necessary for the passage of the gas into the gas-flues, we find that we have an excess of = 144 — 6.74 = 137 feet of an air column. This pressure is too much, for the hot gas would escape through the working doors, to the injury of the workmen. But in making the cross section 2 square feet, the velocity would be $\frac{5832}{60.2} = 48.6$ feet, and to corresponding head = 35.2 feet in an air column, leaving consequently a surplus of 35.2 — 6.74 = 28.46 feet in the combustion canal, K.

Management of the Furnace.—We have here omitted entirely all calculations regarding resistances, etc., as more or less irregularities in the practical working cannot be avoided, and as, consequently, such calculations would be quite illusory.

It will be, however, of much benefit, to use in connection with the furnace a multiplicator manometer, of which we give a sketch with the furnace plans.

The manometer has been known for a long time as a useful instrument to measure the pressure of blast produced by blast machines. The latter is generally of a higher pressure, so that minute divisions on the manometer scale are of not much importance, and the usual instrument is rather inconvenient, as it needs very close observations to see the oscillations corresponding to small differences in the pressure. For very low pressure, however, the usual manometer is not admissible, as it would be difficult, if not impossible, to determine such small differences as parts of an inch in a water column. It was Peclet who first proposed a manometer, which answered the purpose of measuring very small pressures; Mr. Schinz improved the same materially, and presents it in the following construction:

Fig. I, to III, represents a sheet-iron box, g, of 20″ length, 6″ breadth, and 4″ height, with a separate capsule of 4½″ diameter within, which reaches nearly to the bottom of the box, and is open on both ends.

The cross section of the box, inclusive the capsule, is 20.6 = 120 square inches; the cross section of the capsule is ¼. ($4\frac{1}{2}^2$.314) = 15,896 square inches.

The highest pressure of the wind is calculated in this case to 2″ in a water column. If we have that pressure, the height of the water in the box will be 1″, and in the capsule 3″. As soon as this pressure ceases, the water in the box will rise in proportion of 120: (2 + 15.896) = 0.2649″ (as the capsule contains 2.15896 cubic inches), above the original water-level in the box, and at its sinking, the water in the latter rises 0.2649 inches. If we lower the level by a pressure of 2″, the water in the capsule consequently rises only 2 — 0.2649 = 1.7351″.

This movement is now to be transferred to a mechanism which shows this difference multiplied on a circle or a part of it. This mechanism consists simply in a swimmer, a, from which a silk thread, b, goes over a roller, c, and is counterbalanced by the weight, d.

The hand, *e*, has a length of 18″, which multiplies, therefore, the movement of the roller, *c*, and shows it on the arc, *l*.

The cord of this arc has a length of 24″, and the angle at $c, = 84°$. The arc itself has 26.376″ in length, which the hand, *c*, has to pass to make a pressure of 2″.

It is of importance now to give the exact diameter to the roller, *c*, so that the hand describes exactly the rise of the water of 1.7351″. The angle at *c*, being 84°, the roller, *c*, must have a diameter corresponding to 1.7351″ for an arc of 84°.

This diameter is $d, = \frac{360.1.7351}{84.3.14} = 2.3682.$

The length of the arc being 26.376″, every inch is equivalent to a pressure of $\frac{1.7351}{26.376} = 0.06578$. *Fig.* 1, of the drawing, represents a longitudinal section; *Fig.* 2, a front view, and *Fig.* 3, a cross section. *A*, is a wooden frame, or rather a box, with a door, *B*, and a window-glass, *C*, at its face. *D*, is the sheet-iron box within; *a*, is the swimmer, *b*, the silk thread, and *d*, the counter balance; *c*, is the roller in *Fig.* 4, in natural size, only designed for a pressure of one inch. The roller, *c*, is supported by the iron plates, *f*, fixed by means of small screws to the wooden frame; *e*, is the hand, and *g*, denotes the sides of the water-box; *h*, is a small tube, closed by a cork, *m*, to regulate the water in the box, and *k*, another tube, to put the manometer in communication with the blast tube; *i*, is a glass pipe, to show the level of the water, and to mark any disorder of the instrument.

Mr. Chase made a communication on the traces of common radicals in the numeration of various languages, and on the original ideas involved in the names of the numbers.

ON THE RADICAL SIGNIFICANCE OF NUMERALS.

The facility with which the vowel u and the nasal consonants combine with letters of every contact,* may, perhaps, naturally account for their frequent occurrence in the formation of the substantive verb;† but it is difficult to explain the various derivative ana-

* See *ante*, Vol. IX, p. 273.

† Eg. au, un, *to be*, ua, *one;* Cp. un, *to be*, *one;* L. sum, unus; Gr. εἰμί, εἶναι; Ger. ein; Dk. uŋ, waŋka, *to be*, waŋća, *one;* Y. wa, ni, *to be;* C. we, *to be;* E. was, were.

logues which appear to be based upon the idea of simple existence, in any other way than by the hypothesis of a unitary origin.

If any conclusive traces of such an origin are still discoverable, we may reasonably look for them in the numeral adjectives, and in other words which denote the simplest and most universal ideas, such as being, man, one, I, near. The words that we have instanced may be so easily associated, that it would not surprise us if their originals were all formed by modifications of a single primitive root, and I think the Aboriginal languages of America furnish us with a pretty satisfactory clue to that root, and to some of its earlier transformations.

We find, for example, Dk.* uŋ, waŋka, *to be*, waŋ, waŋka, waŋća, *a*, *one;* Om. ango, *we are;* Ch. Yih ko, *one*, ngo, no, wo, *I;* L. ego, nos; Ak. ako, *one;* Y. ako, *a male*, *first* (in compound words); Sh. nok, *one;* H. anokhi, Cp. anok, Eg. anuk, *I;* Sha. nicoti, Pa. necat, Po. ngot, Le. nguti or cvati, *one;* Sh. niko, *near* (in inikoyots, *to arrive at a place*, enikota, *to draw tight*); Mn. naka, Cr. hineka,

* The Indian words are taken from Riggs' Dakota Dictionary, Haldeman's Analytic Orthography (Trans. A. P. S. Vol. XI), Hayden's Ethnology and Philology of the Indian Tribes of the Missouri Valley (Ibid. Vol. XII), Gibbs' Dictionary of the Chinook Jargon, and Rasle's Abnaki Dictionary. I am also indebted to Prof. Haldeman's valuable essay for many Oriental numerals.

ABBREVIATIONS.

Ab. Arabic.
Abn. Abnaki.
Ak. Arikara.
Ap. Apache.
Ar. Arapoho.
Arm. Armenian.
At. Atsina.
Bl. Blackfoot.
C. Chinese.
Cd. Coordish.
C. F. Cape Flattery.
Ch. Chippeway.
Chc. Choctaw.
Chk. Cherokee.
Ck. Creek.
Cl. Chaldee.
Cn. Chinook.
Co. Comanche.
Cp. Coptic.
Cr. Crow.
Dk. Dakota.
E. English.
F. French.
G. German.
Gb. Grebo.
Go. Gothic.
Gr. Greek.
H. Hebrew.
Hb. Irish.
Hm. Hamitic, or Egyptian.
Ip. Ipai.
Ir. Iroquois.
Kn. Kansas.
L. Latin.
Le. Lenape.
Ma. Malay.
Mn. Mandan.
Nd. Nadaco.
Om. Omaha.
Os. Osage.
Pa. Passamaquoddy.
Pn. Penobscot.
Po. Potewatemi.
Pr. Persian.
Pw. Pawnee.
S. Sanskrit.
Sh. Shyenne.
Sha. Shawanee.
Sy. Syriac.
Tm. Tamil.
W. Welsh.
Wa. Waco.
Wl. Wallachian.
Wy. Wyandot.
Y. Yoruba.
Yu. Yuma.

now (nearness in time); Bl. anuks, nakotsio, *small;* S. nicaſa, Y. nikusa, G. nach, W. nig, E. nigh; Ar. nakait, At. nakasé, *to sleep* (i. e. *to draw the eyes tight*), Ma. nok, *sleeping with the eyes,* Ak. hinuk, *night,* S. nactam, *at night,* Gr. νύξ, L. nectere, nox, nux. The association of the ideas of unity and nearness is confirmed by Abn. pezeku, *one,* pessut, *it is near.*

Traces of a common radical are found in many of the words which denote *one* and *ten.* E. g. Sh. nok, *one;* Ak. nukini, *ten;* Pw. peta, *man,* Cree. peet, *one,* Ak. pit, *one* (in pitiku = pit ako = 1, 1 = 2), Tm. paty, *ten;* Bl. matapi, *man,* Cr. hamat, Ck. hemkin, Mn. macana, Am. meg, mi, Gr. μια, Kn. micctse, *one,* Eg. met, mnt, Cp. met, Cree mitatat, wetatat, Sh. matokts, Ar. metaitok, At. matatasits, Ch. mitaswi, Sha. matatvi, Po. matatso, Pn. mdala, *ten.*

From roots indicative of division may be derived words signifying *one* (a piece), *two* (divided), *five* (one hand), *ten* (one tale, or one completed count). E. g. Ap. tahle, *one,* Chk. tali, *two,* Chc. taθlapi, Esk. tetlamet, *five,* Le., Pa. telan, *ten,* E. deal, dale, tale, tally, toll; Ck. hokolin, Chc. tuclu, *two,* Chc. pucoli,* *ten;* Ap. daki, Ir. tekin, *two,* Pa. dec, *ten?* (in escvonadec, *nine* = 10 — 1) Gr. δεκα; Nd. vistsi, *one,* Wa. vitf, *two,* L. bis, Nd. bit'h, *two,* binaja, *ten,* Yu. kavic, *two,* Dk. koviŋ, *two* (in ſakoviŋ, *seven* = *second two*), Ir. uisc'h, Wy. uviſ *five,* S. vi, a particle denoting *division* or *separation,* S. dvi, C. tuy, *a pair.*

A portion of the roots which appear to be properly embraced in this class, deserve especial notice on account of the important part that they play in the formation of the numerals from six to ten. Among their analogues are L. seco, secundus, sequor; S. satſ, C. suy, F. suivre; Cr. akpi, *added to;* Dk. ake, *again,* saŋpa, *more;* Ar. thakuina, *to follow after one.* E.g. Chk. sacvo, Ir. asca, Wy. scat, Pr. pesac, C. F. tſacvak, *one;* Sha. nisvi, *two;* Le. cvataſ, 6 = *second one,* niſaſ, 7 = *second two,* χaſ, 8 = *second three;* Ch. i̧godvasvi, *second one;* ni̧ʝvasvi, *second two,* niſvasvi, *second three;* Pn. necud-as, *second one,* tamba̧v̧-as, *second two,* nsa̧-sac, *second three;* Sha. nicotvaθvi, *second one,* nisvaθvi, *second two,* nθvasicθvi, *second three;* Dk. sakim, *both,* ſacpi, *second one,* ſacoviŋ, *second two,* ſacdogaŋ, *second three;* C. F. aclesab, 8 = *two from the second,* sacvasab,

* This root c–l is probably a corruption of the preceding t–l. For we find Chk. tali, *two,* calcvoci, 2 + 5, *seven;* Ck. hokolin, *two,* culapacin, *seven.*

9 = *one from the second;** Ip. ſakoq, Yu. sakoq, Chr. scahi, C. sap, Ma. sablas, *ten.*

In some of the Algonquin dialects, the word palin is used for *five* or *ten.* E. g. Ck. palin, *ten;* Le. palinaχ, or palinu̜c, Pn. palinascu, = *one palin, five.* The resemblance to Gr. πάλιν is significant. We find in Chinese pa, *to turn the back upon, to put asunder,* pa', *numeral of things grasped with the hand* (compare S. pantſan, Co. manucht, *five,* L. manus, Hm. mn, *fore-arm, shin*), lin, *five families, neighbors, the appearance of numbers.*

Some successive probable derivations can be traced to an extent that is wonderful, considering that the languages have no literature or other means of checking dialectic variations. Thus a satisfactory connection, in my opinion, can be traced between Wa. tau, *three,* and Dk. loga (in shageloga, *eight* = *second three*), through the intermediate forms Dk. dogaŋ, Le. naχa, Nd. dahau, Wa. tau. Le. aſ, *second,* and Wa. tau, *three,* give S. aſtau = Gr. ὀκτώ, *eight.* Po. ſaca, Kn. ſoŋca, Dk .naptſioŋka, naptſiŋwaŋka, *nine* (nape, *hand,* napin, *both,* napin-tſiŋ-waŋka = *both wanting one*), are all probably affiliated.

Some instances of special resemblance, which, if unsupported, might be regarded as accidental, are entitled to consideration in connection with the broader analogies that have been pointed out. Such are Co. semmus, *one;* Ma. sembilam (*one from ten*), *nine;* Cn. elip, *first, before,* H. aleph; Ip. sin, C. sing, L. singulus, *one;* C. si, Pa. sis, Cd. sise, Pr. si, *four;* Ak. ćatiſ, S. ćatur, *four;* Wy. tsutore, Ir. tsata, S. saptan (all of which may be formed by Vesperian roots signifying *second two*), *seven;* Ak. nukinivan (= *one from ten*), S.

* Duponceau, in his Volney prize essay (Mémoire sur le Système Grammatical, &c., p. 59), makes the following reference to the Algonquin numerals. "Mais de cinq à dix ces langues suivent une autre méthode, et c'est la meme que celle qui a été suivie par l'inventeur de chiffres romains. Pour six, on dit cinq un, pour sept cinq deux, pour huit cinq trois et pour neuf un dix, c'est-à-dire dix moins un, ce qui répresente exactement les caractères numeriques VI, VII, VIII, IX. Cet ordre d' idées n' existe point dans la langue de l'ancienne Rome, et cependant se trouve dans sa numeration écrite et abrégeé. D'ailleurs on ne l'aperçoit point dans la formation des noms de nombre des autres langues connues."

Hager (Explanation of the Elementary Characters of the Chinese, &c.) has pointed out the resemblance of the Chinese and Roman numerical characters, and I subjoin some of my reasons for believing that the resemblance is traceable in many of the Aryan, Shemitic, Hamitic, and Turanian languages, as well as in their "numeration écrite et abrégeé."

navan, L. novem, *nine;* At. enanapetasits, Gr. εννεα; Gb. pu, Chc. pucoli, Bl. kipua, *ten.* I have elsewhere* suggested the affinity of S. ćatur and C. ćat ur, *doubled two;* analogues to ćat are found in Ak. ćitu, *the whole,* Ar. ćia, *again,* Dk. ići, *together,* oćitkoŋza, *equal;* ur is equivalent to Le. aſ, *second;* ćatiſ & tsutore may, therefore, be reasonably regarded as the precise equivalents of Oriental ćat ur.

There are some anomalies, for which I have been unable to hit upon any explanation that entirely satisfies me. E. g. Sh. nok, *one,* Bl. nok, *three;* Sha. nisvi, *two,* Ch. nisvi, *three,* Bl. nisvi, *four;* Dk. zaptaŋ, Os. sata, *five,* S. saptan, Ir. tsata, C. tsat, tſat, *seven.* The analogies may probably be best accounted for by roots signifying *division* or *sequence.*

If Ip. and Yu. *sin,* Co. *sem,* C. *sam,* are, as seems very probable, allied to S. sam, Gr. σύν, L. sumo, con, cum, Hm. sm, *to gather,* we can trace some very interesting resemblances to the monumental Egyptian or Hamitic numerals. E. g.

One. Hm. ua, uot; Dk. waŋ; Ak. wan; Tm. wana꜀; L. unus; Po. ngot.

Two. Hm. snau, sente; H. ſne, ſnim; Gb. sa꜀. The root ſn in some of the Shemitic dialects is modified into θn or trn, as in Ab. iθnain, Cl. tren, Sy. trin (compare Tm. rendu? L. semi?).

Three. Hm. χament, χamet;† Ip., Yu. χamoq; C. sam; Gb. ta꜀ (Cn. q'qlon? Ap. t'he?); Le. naχa; Mn. nameni; Dk. yamni. The above-noted Shemitic equivalence of ſ and tr, may account for the Aryan form tri.

Four. Hm. ftu, ftou; Che. ufto; Os. toba. Bunsen suggests that ftu may be derived from 1 + 3. From Vesperian analogy, as well as from the Hm. forms for five and seven, I suspect that f is another form of the root of division, vi (compare L. findo).

Five. Hm. tu, tiu (*a division?*). Compare C. woo, Wy. uviſ, *five;* Chc. tuclu, *two;* Sy. trin, *two;* Wl. trintſ, *five.*

Six. Hm. sou, so (*second* or *following?*). Compare C., Cl. suy; Dk. ſakpi, S. ſaſ, H. ſeſ, *six;* L. sex, secundus.

Seven. Hm. saχf, saχfe, χasfi; Dk. ſakowiŋ; H. ſeba꜀; Go. sibun Hb. ſoct.

Eight. Hm. χmen, χmeni (*second three*); H. ſmnah. See Three.

* Chinese and Indu-European Roots and Analogues, p. 2, and *ante* v. VIII, p. 11.

† χ inclining to ſ.

NINE. Hm. psit; Le. pefcu̜c (= pesac, *one* [*sum?*], ćiŋ, wanting, waŋka, *one*); Bl. piksua.

TEN. Hm., Cp. mnt, met, meti; Sha. metatvi; Po. matatso̜; Cree mitatat, mitatano; Shy, matokto; At. matatasits. Compare Cp. meti, *half;* L. medius, dimidium; S. madhya̜; Y. medji, *two.* Roots denoting measurement (metior, mete, &c.), may very naturally have been derived from the same root as met, *ten.*

From comparisons like the foregoing, it appears that the primitive numerals, so far as I have been able to trace their probable origin, were intended to convey the following ideas:

ONE. Existence, a piece, a group.

TWO. Division, repetition.

THREE. Collection.

FOUR Twice two.

FIVE. Hand, division, collection.

SIX. Second one, five-one, twice three.

SEVEN. Second two, five-two.

EIGHT. Second three, five-three, twice four, two from ten.

NINE. One from ten, three threes.

TEN. One (group), two (fives).

Pending nominations Nos. 534, 535, 536, and 537, were read.

A discussion took place respecting the remaining volumes of Duponceau's Memoir on the Chinese Language.

And the Society was then adjourned.

Stated Meeting, March 3, 1865.

Present, ten members.

Dr. WOOD, President, in the Chair.

A letter inclosing a photograph was received from Mr. C. A. Schott, dated Washington, March 1, 1865.

Donations for the Library were received from the Royal Astronomical Society, Prof. James Hall, the Franklin Institute, the Academy of Natural Sciences in Philadelphia, the National Academy, and Mr. C. H. Hart.